altair™ 8800b Turnkey

PROM Monitor User's Guide

MITS

a subsidiary of **Pertec Computer Corporation**

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1. ABSTRACT

This document describes the function and operation of the Altair 8800b Turnkey PROM Monitor. The PROM Monitor is a system program that allows the user to examine and change any memory location or series of locations, punch the contents of any range of memory locations in Altair Absolute Load Tape format and start execution of a program at any specified address. A source listing of the 8800b Turnkey PROM Monitor is provided so that its I/O and octal conversion routines can be used in other programs.

2. STARTING THE PROM MONITOR

a) The Monitor PROM must be installed in PROM socket J1 on the Turnkey Module.

b) The AUTO-START address switches on the Turnkey Module must be set to 176400 octal and the PROM address switches to 176000 octal.

c) Turn power on.

d) The PROM Monitor prints its prompt character, a period (.).

e) At any time, pressing the START switch causes control to return to the Monitor and the prompt to be printed.

NOTE

The input routines in the PROM monitor will accept only valid octal digits (0-7) and the "space" character. When waiting for input, the routines expect either three or six digits. All of the expected digits need not be input. The first space character terminates the input routine and may be used to delimit separate inputs. If no digits have been entered before the delimiting space is entered, the input routine will return a value of zero. Whenever the delimiting space is used, the carry bit is set, and the return is made. During a normal return (i.e., one in which no space was used), the carry bit is always clear.

3. OPERATION

The Prom Monitor has three commands:

M	Memory examine and change
D	Memory dump
J	Jump to user program

a) The M command. The M command allows the user to examine and change any location in the Altair 8800b memory. The form of the M command is as follows:

Mxxxxxx

where xxxxxx stands for from zero to six valid octal digits. The PROM Monitor opens the location specified and displays the three digit octal contents of that location. The Monitor then waits for three valid octal digits. Three complete octal digits must be input; the space character cannot be used as a delimiter in this case. When this valid data has been received, the Monitor attempts to place the data into the opened location. Once the deposit has been made and verified, the M function closes the current location and opens the following location. If the user tries to deposit information into nonexistent memory, ROM, or protected RAM, the bad deposit causes "?" to be printed on the terminal and control to return to the Monitor. Assuming a valid deposit, this sequence continues until a non-valid character (any character except the digits 0-7) is input. This non-valid character is flagged with a "?" and control returns to the Monitor. This is the normal way to return to the Monitor.

If a space is input instead of a valid octal character, the M function closes the present location without making any changes and then opens the next consecutive location. While the M command is looking for input, the space character may be used at any time to close the current location without change, and open the following location. Therefore, even though one or two valid octal digits may have been input, when the space has been received, the location is closed without change. To deposit new data, three complete valid octal digits must be input.

b) The D command. The D command allows the user to dump the contents of the Altair 8800b's memory between any two locations. The D command has the following form:

Dxxxxxx xxxxxx

To use the D command, type a D in response to the Monitor's prompt character. The D function will then wait for the starting address (zero to six valid octal digits). If six digits are input, the D function prints a space and then waits for the ending address (zero to six valid octal digits). The ending address must be greater than or equal to the starting address. If less than six digits are input during the starting address, the D function echoes the delimiting space character, but does not print one of its own.

Once the D function has received valid starting and ending addresses, it punches a leader of 60 octal 302's followed by 60 nulls (zero bytes). It then punches out the contents of memory starting at the first address up to and including the end address in the Altair 8800b binary Absolute Load Tape format, as shown in Table A. (The word "punch" is used here to refer to the output of the D command, no matter what output device is actually used.) If the number of bytes to be punched is greater than 377 octal, the D function punches as many blocks of 377 octal bytes as necessary until the number of bytes left to punch is less than 377 octal bytes. The last block punched may have less than 377 octal bytes. If the number of bytes to be punched in the last block is equal to zero, a zero block is not punched. Upon completion of the dump, the D function performs a carriage return and line feed and then returns to the Monitor.

c) The J command. The J command allows the user to transfer control between the monitor and another program. The J command has the following form:

Jxxxxxx

where xxxxxx is the starting address of the user routine (zero to six valid octal digits). Once the J function has received a valid address, it will load the program counter with the address and start execution of the user program at that address.

4. MEMORY SPACE AND STACK CONSIDERATIONS

The PROM Monitor is 256 decimal or 377 octal bytes long and is assembled to operate with a starting address of 176400 octal. It must be located at this point in memory or it will not operate correctly. The PROM Monitor establishes a stack with a top address of 175000 octal when it is entered. The Monitor never has more than four levels of subroutine calls at any one time, so only eight bytes are actually used in the stack. The stack itself usually resides in the 1K of RAM that is part of the Turnkey Module. It is the user's responsibility to see that there is RAM available at the stack location. Otherwise, the Monitor cannot operate correctly, if at all.

All necessary registers and the stack pointer should be saved before jumping from a program to the Monitor, since the Monitor destroys the contents of the stack pointer and all registers upon entry. Restoration of the registers must be handled by the user's program.

5. ERROR CONSIDERATIONS

Errors in data input can be corrected easily before the last character is typed. Simply type a non-octal character (except space) and the monitor will print a question mark and a period. The command may then be typed again.

When the octal input routines are requesting input, they do not check for over-range conditions on the input data. For example, when using the M function, three complete valid octal digits must be input in order to deposit new data into a memory location. Since the Altair 8800b is organized around an eight bit byte, the largest valid octal number that can be input is 377. In fact, 777 can be input without the Monitor detecting an error. The actual value that is deposited in the memory location in that case is not equal to 777 octal, but depends upon the binary representation of the most significant digit input to the routine. For example, 477 causes the routine to deposit octal 077 into the memory location. The same possible error condition is present when addresses are input, except that the maximum value that may be typed is 1777777. Anything larger will not be flagged as an error, but the effective address will depend upon the binary representation of the highest order digit.

6. RUNNING BASIC WITH THE PROM MONITOR

The Altair 8800b PROM Monitor greatly speeds the process of loading Altair BASIC and can be used whether or not the Multi-Boot Loader or Disk Boot Loader PROMs are in use.

A. Without the Loader PROMS. The usual procedure for loading BASIC involves toggling a loader program in from the front panel and using it to load a paper tape or cassette version of BASIC. If the PROM Monitor is installed, this bootstrap loader can be entered from the terminal in octal instead of from the front panel switches in binary.

To do this, type M000000 (or M <space>) in response to the Monitor's prompt. After the Monitor displays the current contents of the first location in memory, type the first entry in the "OCTAL DATA" column in the applicable loader program. The loaders are found in Appendix B of the Altair BASIC Reference Manual. After three digits are typed, the Monitor closes the current location and opens the next location. This process is repeated until the entire loader program is entered. The program can be checked by typing a non-octal character to return to the Monitor and again typing M000000 (or M <space>). As the contents of each location are displayed, typing a space causes the Monitor to display the contents of the next location without making any modifications.

Once the loader program has been entered and verified, the paper tape or cassette tape of BASIC is loaded and positioned in the load device according to the directions in the BASIC Reference Manual. Then the loader is started by typing J000000 (or J <space>). The terminal should print BASIC's "MEMORY SIZE?" initialization question after BASIC has been loaded. At that point, BASIC is in control.

B. With a bootstrap loader PROM. If either the Multi-Boot Loader or Disk Boot Loader PROM is installed, the response to the Monitor's prompt should be Jxxxxxx, where xxxxxx is the starting address for the loader in use. For the Multi-Boot loader, the starting address is 177000. For the Disk Boot Loader, the starting address is 177400. For more information, see the Multi-Boot Loader Manual and the Altair 8800 BASIC Reference Manual.

TABLE A

ABSOLUTE LOAD TAPE FORMAT

Begin/Name Record

Byte #	Contents	Comments
1	125 Octal	Begin Sync
2-4	Name	Program name
5-N	Comments	Program version and date, etc.
N+1	15 Octal	Terminates program name record

Program Load Record

Byte	Contents	Comments
1	74 octal	Load sync byte
2	0-377 octal	Number of load bytes
3	L.S. Byte	of Load address
4	M.S. Byte	of Load address
5-N	Data Bytes	
N+1	Checksum Byte	Generated by adding all bytes except the first two without carry

End-of-file record

Byte	Contents	Comments
1.	170 octal	Paper tape/Audio Cassette EOF
2-3		Execution start address

```
00010   ;*****************************************************************
00020   ;*                                                               *
00030   ;*  THIS IS A 256 BYTE PROM MONITOR FOR USE WITH THE ALTAIR       *
00040   ;*  8800B TURNKEY MODULE.  THIS MONITOR PROVIDES THE USER WITH    *
00050   ;*  THE FOLLOWING FUNCTIONS:                                     *
00060   ;*                                                               *
00070   ;*      1)  MEMORY EXAMINE AND CHANGE FUNCTION                   *
00080   ;*              YOU CAN EXAMINE AND CHANGE THE CONTENTS OF ANY   *
00090   ;*              VALID MEMORY LOCATION                            *
00100   ;*      2)  MEMORY DUMP FUNCTION                                 *
00110   ;*              YOU CAN DUMP IN THE ALTAIR BINARY PUNCH FORMAT   *
00120   ;*              BETWEEN ANY TWO VALID MEMORY LOCATIONS           *
00130   ;*      3)  JUMP TO FUNCTION                                     *
00140   ;*              YOU CAN CAUSE THE MONITOR TO JUMP TO ANY         *
00150   ;*              LOCATION AND START EXECUTING THE PROGRAM THERE   *
00160   ;*                                                               *
00170   ;*  THE MONITOR CAN BE REENTERED FROM THE USER'S PROGRAM          *
00180   ;*  SO THAT THE FEATURES OF THE MONITOR ARE ALWAYS AVAILABLE      *
00190   ;*  TO ANY USER PROGRAM.                                         *
00200   ;*                                                               *
00210   ;*****************************************************************
00220   ;
00230   TITLE TURMON - MITS TURNKEY MONITOR PROM
00240   ;
00250   ;MITS TURNKEY MONITOR
00260   ;C.W.  VERTREES              01/13/77
00270   ;REVISED                     01/17/77
00280   ;                            01/19/77
00290   ;                            01/20/77
00300   ;
00390   ;CONSTANTS
176000  00400   STACK=176000
```

```
                00010   ;
                00020   ;MONITOR STARTS AT THIS LOCATION
                00030   ;BEGINNING OF PROM
                00040   ;
                00050   ;MONITOR CONTROL STRUCTURE
                00060   ;
176400'         00070   RELOC 176400
176400'         00080   MON:    MVI     A,003           ;RESET 2SIO
176401'
                00090   IFN REALIO,<
176402'         00100           OUT     20              ;AND INITIALIZE
176403'
176404'         00110           MVI     A,021
176405'
176406'         00120           OUT     20
176407'
                00130   >
176410'         00140   ENTER:  LXI     SP,STACK        ;LOAD STACK
176411'
176412'
176413'         00150           CALL    CRLF            ;FORMAT OUTPUT
176414'
176415'
176416'         00160           MVI     A,"."           ;HELLO MONITOR
176417'
176420'         00170           CALL    OUTCHK
176421'
176422'
176423'         00180           CALL    INCH            ;WHAT TO DO?
176424'
176425'
176426'         00190           CPI     "M"
176427'
176430'         00200           JZ      MEM             ;DO MEMORY EXAMINE
176431'
176432'
176433'         00210           CPI     "D"
176434'
176435'         00220           CZ      DMP             ;DO A MEMORY DUMP
```

```
176436'         00230           CPI     "J"
176437'
176440'         00240           JNZ     ENTER           ;NOT A VALID CMD
176441'
176442'
176443'         00250           CALL    OCTL6           ;DO JUMP, GET ADDR
176444'
176445'
176446'         00260           PCHL                    ;LOAD PC AND GO
176447'
176450'
                00010   ;THIS CONTROL STRUCTURE HANDLES THE MEMORY
                00020   ;EXAMINE AND CHANGE FUNCTION
                00030   ;
176451'         00040   MEM:    CALL    OCTL6           ;GET ADDRESS
176452'
176453'
176454'         00050           INST    076             ;"MVI A," SKIP NEXT (BOMB A)
176455'         00060   CONT:   INX     H               ;INCREMENT ADDRESS
176456'         00070           CALL    CRLF            ;NEW LINE
176457'
176460'
176461'         00080           MOV     D,H             ;STORE ADDRESS IN D/E
176462'         00090           MOV     E,L
176463'         00100           CALL    PRINT6          ;PRINT ADDRESS
176464'
176465'
176466'         00110           LDAX    D               ;LOAD DATA
176467'         00120           MOV     H,A
176470'         00130           CALL    PRINT3          ;PRINT DATA BYTE
176471'
176472'
176473'         00140           CALL    OCTL3           ;GET NEW DATA
176474'
176475'
176476'         00150           XCHG                    ;RESTORE ADDRESS
176477'         00160           JC      CONT            ;NO NEW DATA
176500'
176501'
```

```
176502'         00170           MOV     M,A             ;STORE DATA
176503'         00180           CMP     M               ;COMPARE DEPOSIT
176504'         00190           JZ      CONT            ;OK, DO NEXT
176505'
176506'
176507'         00200   ERR:    MVI     A,"?"           ;FLAG BAD DEPOSIT
176510'
176511'         00210           CALL    OUTCHK          ;PRINT "?"
176512'
176513'
176514'         00220           JMP     ENTER           ;RETURN TO MONITOR
176515'
176516'
                00230   ;ERROR CONDITIONS RETURN TO MONITOR VIA "ERR"
                00010   ;THIS CONTROL STRUCTURE RUNS THE MEMORY DUMP FUNCTION.
                00020   ;
176517'         00030   DMP:    CALL    OCTL6           ;GET START
176520'
176521'
176522'         00040           XCHG                    ;STORE IN D/E
176523'         00050           CNC     SPACE
176524'
176525'
176526'         00060           CALL    OCTL6           ;GET END
176527'
176530'
176531'         00070           MVI     A,015           ;LOAD LEADER CHAR
176532'
176533'         00080   X1:     MVI     B,^D060         ;LOAD LEADER CNTR
176534'
176535'         00090   X2:     CALL    OUTCHK          ;PUNCH LEADER
176536'
176537'
176540'         00100           DCR     B
176541'         00110           JNZ     X2
176542'
176543'
176544'         00120           CMP     B               ;THROUGH WITH LEADER?
176545'         00130           MOV     A,B
176546'         00140           JNZ     X1              ;PUNCH NULLS
```

```
176547'
176550'
176551'  00150            MOV     A,L             ;SUB START FROM END
176552'  00160            SUB     E
176553'  00170            MOV     L,A
176554'  00180            MOV     A,H
176555'  00190            SBB     D
176556'  00200            MOV     H,A             ;HL CONTAINS TOT BYTES
176557'  00210            INX     H               ;INCREMENT TOT BYTES
176560'  00220  BLOCK:     DCR     B               ;B=377Q
176561'  00230            MOV     A,H
176562'  00240            ORA     A               ;MORE THAN ONE BLOCK?
176563'  00250            JNZ     NOTLST          ;NOT LAST BLOCK
176564'
176565'
176566'  00260            MOV     B,L             ;LAST BLOCK
176567'  00270  NOTLST:    MVI     A,074
176570'
176571'  00280            CALL    OUTCHK          ;PUNCH "START OF BLOCK"
176572'
176573'
176574'  00290            MOV     A,B             ;B=BYTE CNTR
176575'  00300            CALL    OUTCHK          ;PUNCH BYTE COUNT
176576'
176577'
176600'  00310            MVI     C,0             ;CLEAR CHECKSUM
176601'
176602'  00320            MOV     A,E             ;PUNCH LOAD ADDR
176603'  00330            CALL    OUTCHK          ;L.S.  BYTE
176604'
176605'
176606'  00340            MOV     A,D
176607'  00350            CALL    OUTCHK          ;M.S.  BYTE
176610'
176611'
176612'  00360  DATA:      LDAX    D               ;GET DATA BYTE
176613'  00370            CALL    OUTCHK          ;PUNCH IT
176614'
176615'
```

```
176616'          00380                INX     D                ;INCREM ADDR
176617'          00390                DCX     H                ;TOTBYTES=TOTBYTES-1
176620'          00400                DCR     B                ;THROUGH W/BLOCK?
176621'          00410                JNZ     DATA             ;NO
176622'
176623'
176624'          00420                MOV     A,C              ;YES, PUNCH CKSUM
176625'          00430                CALL    OUTCHK
176626'
176627'
176630'          00440                MOV     A,H              ;THROUGH W/ALL BYTES?
176631'          00450                ORA     L
176632'          00460                JNZ     BLOCK            ;NO, PUNCH NXT BLOCK
176633'
176634'
176635'          00470   CRLF:        MVI     A,015            ;DO A CRLF
176636'
176637'          00480                CALL    OUTCHK
176640'
176641'
176642'          00490                MVI     A,012
176643'
176644'          00500                JMP     OUTCHK
176645'
176646'
                 00510   ;RETURN TO MONITOR THROUGH OUTCHK
                 00010   ;THIS SUBROUTINE BUILDS 3/6 OCTAL DIGITS IN H&L
                 00020   ;
                 00030   ;SPECIAL RETURN PROVIDED BY A "SPACE", CARRY BIT SET.
                 00040   ;ONLY VALID OCTAL OR "SPACE" ACCEPTED, ALL OTHER FLAGED AND
                 00050   ;CONTROL RETURNS TO THE MONITOR.
                 00060   ;
176647'          00070   OCTL6:   INST    6                ;LOAD B WITH 6, SKIP NEXT
176650'          00080   OCTL3:   INST    6                ;LOAD B WITH 3
176651'          00090            INST    3
176652'          00100            LXI     H,$CODE+0        ;CLEAR H/L FOR LESS THAN 6 DIG RET
176653'
176654'
176655'          00110   AGN:     CALL    INCH             ;GET CHARACTER
```

```
176656'
176657'
176660'         00120           MOV     C,A             ;STORE IN C
176661'         00130           CPI     " "             ;COMPARE TO "SPACE"
176662'
176663'         00140           STC                     ;SET THE CARRY
176664'         00150           RZ                      ;RETURN IF "SPACE"
176665'         00160           ANI     270             ;TEST FOR VALID OCTAL
176666'
176667'         00170           XRI     060
176670'
176671'         00180           JNZ     ERR             ;BAD, FLAG & RET TO MON
176672'
176673'
176674'         00190           MOV     A,C             ;RESTORE CHAR
176675'         00200           ANI     007             ;STRIP ASCII
176676'
176677'         00210           DAD     H               ;SHIFT H&L LEFT 3 BITS
176700'         00220           DAD     H
176701'         00230           DAD     H
176702'         00240           ADD     L
176703'         00250           MOV     L,A             ;PUT OCTAL IN H
176704'         00260           DCR     B               ;THROUGH ?
176705'         00270           JNZ     AGN             ;NO, DO AGAIN
176706'
176707'
176710'         00280           RET                     ;YES, NORM RETURN
                00010   ;THIS SUBROUTINE PRINTS 3 OCTAL DIGITS FROM H
                00020   ;OR 6 OCTAL DIGITS FROM H AND L
                00030   ;
                00040   ;DIGITS ARE FOLLOWED BY A SPACE
                00050   ;
176711'         00060   PRINT6: MVI     B,6             ;LOAD CNTR W/6
176712'
176713'         00070           XRA     A               ;CLEAR A
176714'         00080           JMP     NEXT1           ;SHIFT ONE BIT
176715'
176716'
176717'         00090   PRINT3: MVI     B,3             ;LOAD CNTR W/3
```

```
176720'
176721'          00100              INST    346             ;SKIP NEXT, SHIFT 2 BITS
176722'          00110    NEXT3:    DAD     H               ;SHIFT H/L LEFT 3 INTO A
176723'          00120              RAL
176724'          00130              DAD     H
176725'          00140              RAL
176726'          00150    NEXT1:    DAD     H
176727'          00160              RAL
176730'          00170              ANI     7               ;STRIP OFF OCTAL
176731'
176732'          00180              ORI     060             ;ADD ASCII
176733'
176734'          00190              CALL    OUTCHK          ;PRINT IT
176735'
176736'
176737'          00200              DCR     B               ;THROUGH ?
176740'          00210              JNZ     NEXT3           ;NO, SHIFT NEXT THREE
176741'
176742'
176743'          00220    SPACE:    MVI     A,040           ;YES, PRINT SPACE
176744'
176745'          00230              JMP     OUTCHK          ;AND RETURN
176746'
176747'
                 00240    ;RETURN TO CALLING PROG THROUGH OUTCHK
                 00010    ;THIS SUBROUTINE WILL INPUT A CHARACTER, STRIP
                 00020    ;PARITY AND AUTOMATICALLY ECHO THE CHARACTER.
                 00030    ;IT WILL ALSO OUTPUT A CHARACTER WITH CHECKSUM CALCULATIONS.
                 00040    ;
                 00050    IFN REALIO,<
176750'          00060    INCH:     IN      20              ;READ STATUS
176751'
176752'          00070              RRC
176753'          00080              JNC     INCH            ;NOT READY
176754'
176755'
176756'          00090              IN      21              ;READ CHARACTER
176757'
                 00100    >
                 00110    IFE REALIO,<
```

```
                00120   INCH:   IN      1
                00130   >
176760'         00140           ANI     177             ;STRIP PARITY
176761'
176762'         00150   OUTCHK: PUSH    PSW             ;SAVE CHARACTER
176763'         00160           ADD     C               ;ADD IN CHECKSUM
176764'         00170           MOV     C,A             ;RESTORE CHECKSUM
                00180   IFN REALIO,<
176765'         00190   LOOP:   IN      20              ;READ STATUS
176766'
176767'         00200           RRC
176770'         00210           RRC
176771'         00220           JNC     LOOP            ;READY ?
176772'
176773'
176774'         00230           POP     PSW             ;YES, GET CHAR
176775'         00240           OUT     21              ;PRINT CHARACTER
176776'
                00250   >
                00260   IFE REALIO,<
                00270           POP     PSW
                00280           OUT     1
                00290   >
176777'         00300           RET                     ;FROM WHENCE YE CAME
                00080   END
```

```
NO ERRORS DETECTED

PROGRAM BREAK IS 177000
CPU TIME USED 00:05.334

4K CORE USED
```

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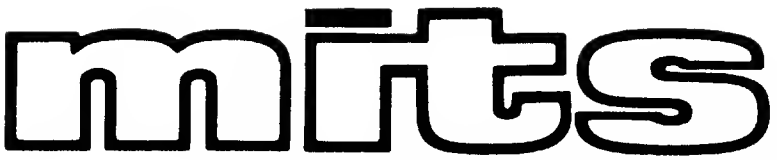

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